Environmental Tax Reform for Green Growth in Korea : The Design of Carbon Tax Scheme*

by

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Abstract

Korea is recently debating the introduction of a carbon levy under its green growth strategy. The government set an ambitious goal of cutting greenhouse gas emissions by 30 percent below expected levels in 2020, and established the Framework Act on Green Growth in 2010 to meet the emission target and promote eco-friendly investment. The government is also preparing for a variety of measures of the green growth and will put those plans into action.

This paper explores the design of a carbon tax scheme for green growth in Korea, focusing on issues related to the tax base, the tax rates, and the use of the revenues. It also shows that the economy-wide effects of a well-designed carbon tax scheme in Korea could be "positive" by making use of a number of other fiscal instruments in combination.

According to this study, the appropriate size of carbon tax revenue would be about 10 trillion Won (approximately 1% of GDP) in Korea. Moreover, from experience in countries that have already implemented eco-tax reform in Europe, we may need a gradual phasing-in of the carbon taxation in broader tax reforms and enhance the use of a public information campaign for stronger incentives and political feasibilities. At the same time, it is also required to consider secondary instruments such as direct compensation payments, price support and tax deductions for unfair burdens of low-income households and more energy-vulnerable sectors. All those approaches might be offset of distributional consequences as mitigating the harmfulness of eco-motivated, new fiscal policies.

Lastly, it is pretty obvious that the more we delay action, the more cost we pay. If we invest green technology in recent economic slowdown, we will have a global initiative that would make our economy more competitive in the long run.

Key Words: Climate Change, Green Growth, Carbon Tax, Environmental Tax Reform

JEL Codes: Q54, Q58, H23

I. INTRODUCTION

The Copenhagen Accord in 2009 is meant to represent a broad political agreement between countries, including G20, accounting for about 80% of global carbon emissions. It requires for developed countries to submit pledges for emissions cuts and climate financial aid by 2020 (as an extension of the Kyoto protocol), and for developing countries to indicate their voluntary actions including targets to cut carbon/energy intensity, to increase renewable energy portion, and/or to reduce deforestation.

Recently fifty-five countries have pledged emission cuts to the UN under the Copenhagen accord.[1] These countries account for 78 per cent of global emissions from energy use, according to a UNFCCC release.

Asia's fourth-largest energy consumer set an ambitious goal of cutting greenhouse gas emissions by 30 percent below expected levels in 2020 (November, 2009). This is one of the most aggressive targets in the non-Annex I countries. It also promotes environment-friendly investment and development (see Table 1).

Korea's announcement was made immediately ahead of the much anticipated climate talks in Copenhagen in 2009. The Korea's target setting is a voluntary and unilateral action, and Korea hopes its efforts will create a more conducive atmosphere for other developing countries' engagement as well as further commitments from developed countries.

The Korea's national strategy of Green Growth is a comprehensive long-term master plan. It envisages three main objectives as follows: (i) to deal effectively with climate change and energy independence, (ii) create new growth engines on multiple fronts, and (iii) to raise overall quality of life for the people and to enhance contribution to the international community through strong advocacy for green growth(PCGG, 2008).

[1] It represents the first time that large emerging economies such as China and India have made written commitments to the international community that they will curb their carbon emissions.

Korea recently established a Comprehensive Act on Green Growth to meet the emission target and promote environmentally-friendly investment and development (January, 2010). The government review is now under way to assess the feasibility of a levy on carbon. It is considering using property, automobile, and energy-carbon taxes to reduce greenhouse gas emissions and promote green growth. It is also pushing for a new Negotiated Agreement(NA) system in 2011 and a national cap-and-trade system legislation in 2015 and for providing support for 10 key green technologies including carbon capture and storage, a smart grid and next-generation batteries.[2]

The Korean government prepared for a variety of measures of the green growth in 2009 and will put those plans into action(Green Tax & Budget Reform; GTBR in Figure 1). Although some companies voiced their worries on the policy direction and many of the Korean companies are newcomers to green industries, Korean companies have been quite supportive of the Green Growth initiative. 640 Korean companies would start participating in a voluntary pilot carbon emissions trading system from 2010.

The government also established the Global Green Growth Institute(GGGI) in Seoul (June, 2010) to help countries share their policy experiences on climate change and to enhance their world-wide green growth strategies.

In particular, the introduction of a carbon tax is becoming part of a major process integrated into an environmental tax reform(ETR) or GRBR in Korea.[3] Study groups, including academics and policy-makers, are evaluating the validity of carbon taxes under the green growth strategy.

[2] A smart grid system enables homes and factories to use electricity during off-peak hours through a two-way communication between power suppliers and consumers. Korea established a major test bed facility for the smart grid system on Jeju Island in 2009, which will be completed by 2013.

[3] In this paper we will use GTBR and ETR interchangeably where the former has a broader concept than the latter.

Table 1. The Copenhagen-Accord Emissions Reduction Targets by 2020

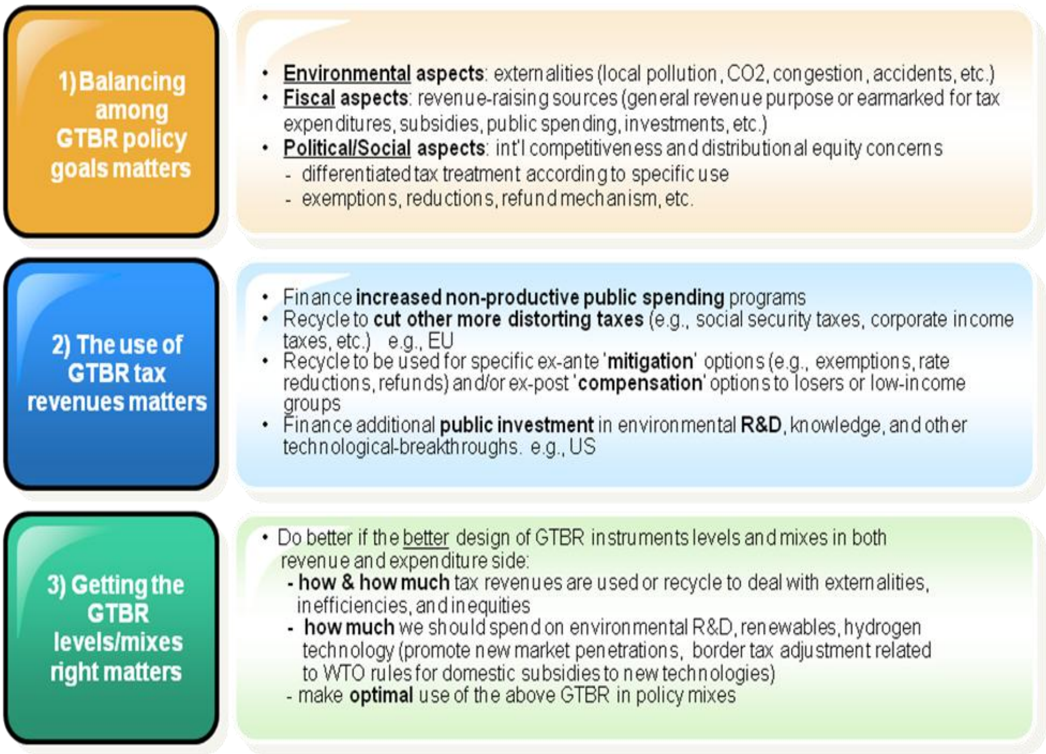
(Unit : %)

	CO2 emissions relative to				Carbon Intensity relative to
	1990 level	2000 level	2005 level	2020 BAU*	2005 level
EU states	20				
Norway	40				
Croatia	5				
US			17		
Canada			17		
Moldova	25				
South Africa				34	
Brazil				38.9	
Russia	25				
Japan	25				
Australia		25			
New Zealand	20				
South Korea				30	
Indonesia				26	
Singapore				16	
China					45
India					25

Note: BAU represents Business as usual case with no climate policy
Source: UNFCCC, 2010; Boao Report, 2010

In Section II, this paper begins with discussing theoretical mechanisms of GTBR as fiscal policies that use incentives and disincentives through taxation and government spending for green growth. Next, Section III explores the design of a carbon tax scheme for green growth in Korea, focusing on issues related to the tax base, the tax rates, and the use of the revenues. It then shows that the economy-wide effects of a well-designed carbon tax scheme could be positive by making use of a number of other fiscal instruments in combination. Finally Section IV offers some concluding remarks.

Figure 1. Objectives of Green Tax and Budget Reform (GTBR)



II. MECHANISMS FOR GREEN GROWTH

2.1 Theoretical Backgrounds

When can environmental fiscal reform boost both economic growth and social welfare? To ensure that economic growth and the preservation of environmental quality are compatible and socially optimal, it is crucial to understand the interactions among economic activities, technological progress, and ecological processes over time. Policies for ecologically sustainable economic growth (green growth) may be more effective if technological progress in abatement knowledge responds to economic incentives. If so, how can environmental investment and taxation contribute to the productivity of private factors of production and to green growth, and how much sustainable development can we expect from these policies?

This section discusses environmental fiscal policies, using Fullerton and Kim (2008)'s model, within an endogenous growth model with pollution, distortionary income taxes, and three assets: natural capital, abatement knowledge, and private capital (both physical and human capital).[4]

Here, individual household utility (*U*) depends on consumption (*C*) of the final good and on the quality of the environment (*N*). This environmental quality is a stock that acts as a nonrival consumption good but also as a productive public input to production. The economy has three types of assets. The first is private capital (*K*, including both physical and human capital), and the second is public abatement knowledge capital (*H*, a nonrival environmental R&D good). Either of these first two types of asset can be accumulated by devoting to it some fraction of output. The third type of asset is environmental quality (natural capital), which is modeled as a stock of a renewable resource. Pollution (*P*) is inevitable from production activities, but it can be reduced by increasing the stock of pollution abatement knowledge (e.g., clean technology) and by imposing environmental regulations on production activities (e.g., pollution standards, permit, or taxes).

Also, 'effective pollution (*Z*),' is an input that can be provided either by actual pollution (*P*) or through the stock of available public abatement knowledge (*H*). Thus, the same output can be achieved with less actual pollution if the firm has access to more abatement knowledge. The parameter ε denotes a pollution-conversion factor (or productivity difference of *P* relative to *H*): a higher ε

[4] Recent advances in endogenous growth theories have opened up the possibility of analyzing the growth effects of various policy changes in the long-run (Fig. A8). In particular, models with the environment along this line argue that a tighter environmental policy may boost growth, at least in the long-run. They derive optimal environmental policies for internalizing environmental externalities in a sustainable growth framework. However, most of these previous models simply assume that the public sector's environmental R&D activities to generate pollution abatement knowledge are financed through lump-sum taxation rather than through other distortionary taxes. Fig. A1 in Appendix depicts a schematic diagram for greening the tax and budget system towards ecologically sustainable economic growth.

makes pollution more effective, or equivalently, makes abatement relatively less effective.[5]

Following Tahvonen and Kuuluvainen (1991), growth and depletion of the renewable natural resource are modeled according to the following accumulation equation (See Fig. A2):

$$\dot{N} = E(N) - P, \quad \text{where } E' \equiv \partial E/\partial N \gtrless 0 \quad \text{and} \quad E'' \equiv \partial^2 E/\partial N^2 < 0, \qquad (1)$$

where N denotes the stock of natural capital (environmental quality), P is pollution, and where a dot over any variable represents the change over time. $E(N)$ represents ecological growth through regeneration processes. This regeneration might initially increase with a larger N (that is, $E' > 0$), but it eventually peaks and declines ($E' < 0$) as the environment approaches its natural state. Thus, natural capital accumulation features diminishing returns ($E'' < 0$). The second term, pollution P, indicates the deterioration of environmental quality through the extractive use of natural resources in production (e.g., using up clean air or water). On a sustainable steady-state path where $\dot{N} = 0$, eq. (1) implies that $P = E(N)$. Thus, $E(N)$ represents the absorption capacity of the environment.

Here, we have three main tensions or sets of opposing forces that affect welfare and growth. First, a cut in pollution has a direct effect that reduces output, but it has an indirect effect that raises output through the increase in environmental quality. A second tension is that growth may cause pollution, but it also generates resources for abatement knowledge that may reduce pollution. The improved quality of the environment or the increased stock of abatement knowledge can allow the economy to absorb a larger flow of effective pollution in the steady state. Finally, the economy also has a tension between the positive effects of investment in abatement knowledge and the negative effects from distortionary

[5] Unlike the literature, we here generalize the treatment of pollution and abatement in production so that they are not equally effective. The addition of this one parameter has important implications, however, as environmental policy no longer must have the same effect on growth as on welfare. This pollution-conversion parameter (ε) reflects mainly "eco-efficiency" related to country-specific production structures or endowment conditions, and so we do not impose any prior restrictions on it. Indeed, we show how the difference between the productivities of man-made input H and natural input P plays a crucial role in determining optimal environmental and fiscal policy. The studies by Bovenberg and Smulders (1995, 1996) do not consider this possibility but just assume $Z = HP$ and $\varepsilon = 1$.

income taxes made necessary by that increase in non-productive government spending.

2.2 Components of Green Tax and Budget Reform

The government here is assumed to raise revenues by adopting a positive income tax rate, τ_K, and a positive pollution tax, τ_P. Tax revenues are used to finance "government expenditures on public investment" ($q_H\dot{H} + q_H\delta_H H$) and lump-sum transfers to households (G). Further, we suppose that government fixes the ratio of the lump-sum transfer payments relative to private income, $\varphi \equiv G/rK$. This parameter is used below as a measure of the extent to which distorting taxes are necessary. Assuming a balanced budget at any moment, the budget constraint of government can be written as:

$$\tau_K rK + \tau_P P = q_H\dot{H} + q_H\delta_H H + G, \quad \text{or (dividing by } rK\text{)}, \tag{2a}$$

$$\tau_K + \tau_P P/rK = \zeta + \varphi, \tag{2b}$$

where $\tau_P P/rK$ represents the ratio of pollution tax revenue to private capital income,[6] and where $\zeta \equiv \left(q_H\dot{H} + q_H\delta_H H\right)/rK$ is the ratio of gross public investment in abatement knowledge to private capital income.[7]

For the market economy described above, a benevolent government needs to intervene to ensure the optimal provision of the two public goods N and H. In this case, where lump-sum taxation is not available, it is important to know how the public investment in abatement knowledge is financed and what becomes of the taxes collected. Government must take as given the decentralized optimizing behavior of firms and households, the ecological constraint, and government budget constraint, while affecting the allocation of resources among the three type of capital (K, H, and N) through its policy variables (τ_K, τ_P, and $\dot{H}$). Then, in this second-best world, it must act to satisfy the following 'arbitrage condition':

[6] From the firm's first-order conditions, we know that the ratio of pollution tax revenue to private capital income is $\tau_P P/rK = \alpha\varepsilon/(1-\alpha)$, which is always constant in our economy.

[7] For environmental and non-environmental taxes in OECD countries, see Fig. A13 in Appendix. In particular, this shows environmental tax burden relative to other taxes in 2002.

$$\underbrace{(1-\tau_K)r-\delta_K}_{\textit{rate of return on private capital}} = \underbrace{\frac{1}{q_H}A\frac{\partial F}{\partial Z}P^{\varepsilon}+\frac{\dot{q}_H}{q_H}-\delta_H}_{\textit{rate of return on abatement knowledge}} = \underbrace{\frac{1}{\tau_P}\left[\frac{\partial U}{\partial N}/\frac{\partial U}{\partial C}+F\frac{\partial A}{\partial N}\right]+\frac{\partial E}{\partial N}+\frac{\dot{\tau}_P}{\tau_P}}_{\textit{rate of return on natural capital}} \; , \quad (3)$$

which says that investments in the three types of capital are traded off against each other and also against household savings. The first equality in eq. (3) says that the net return on private investments [$(1-\tau_K)r-\delta_K$] should match the return on investment in abatement knowledge (consisting of the current return in production and a capital gain), given the economy-wide pollution level, P. The second equality in eq. (3) says that environmental quality N should also earn the same rate of return as public abatement knowledge. The return on environmental quality in eq. (3) consists of (i) its contribution to utility (the consumption externality), (ii) its contribution to total factor productivity (the production externality), (iii) its contribution to ecological processes (marginal absorption capacity), and (iv) a scarcity rent (capital gain). The Hotelling rule states that if the natural resource is exhaustible, the rate of its price increase ($\dot{\tau}_P/\tau_P$) should equal the rate of return on private capital. Hence, eq. (3) can be interpreted as a generalized Hotelling rule for renewable natural resource (in the presence of distortionary taxation).

Optimal corrective policy rules in our economy induce the market equilibrium path to match the socially-efficient path. What level of policy rules should then be adopted to maximize social welfare, including concerns about global warming, and how do the resulting long-run growth outcomes react to changes in the set of economic and natural parameters in the economy? These questions often arise in environmental fiscal policy debates over greenhouse gas (GHG) abatement.

How are growth and welfare affected by a tighter environmental policy in the presence of the externalities and distortionary taxation? It is typically argued that pollution control hurts growth by raising abatement costs.[8] With endogenous growth, however, environmental policy may have permanent effects on the

[8] Most of the early literature assumes exogenous technological progress that is independent of environmental policy as in Fig. A8. See Jorgenson and Wilcoxen (1990), Nordhaus (1994), and Goulder (1995) among many others. In these models, environmental protection has costs that reduce growth (see Fig. A9).

productivity of the economy. If pollution taxes are sub-optimally low, for example, then pollution is excessive. Natural capital is then under-accumulated, which affects production.

To investigate the growth effects of tighter environmental policy, we can see the long-run growth rate then reacts to changes in pollution taxation as:

$$\frac{dg}{d\tau} = \underbrace{-\sigma\left(\frac{d\tau_K}{d\tau}\right)}_{\textit{tax replacement effect}} r + \underbrace{\sigma(1-\tau_K)\frac{1-\alpha}{\alpha\varepsilon}E(N)\left(1-\eta_{EN}\eta_{N\tau}\right)}_{\textit{improved productivity effect for private capital}}, \tag{4}$$

where $\eta_{N\tau}\left(\equiv (dN/d\tau)(\tau/N)\right)$ is the elasticity of natural capital with respect to the pollution tax and $\eta_{EN}\left(\equiv -(dE/dN)(N/E)\right)$ is the elasticity of the absorption capacity of the environment with respect to natural capital. In our model, the curve that relates environmental tax rates and their growth (or welfare) effects can now be in an "*inverted* U-shape" function. Also, we can have the relationship between the growth-maximizing pollution tax and the welfare-maximizing pollution tax.

$$\underbrace{\frac{dW}{d\tau}}_{\textit{welfare effect}} = \frac{K(0)\left(C(0)N^{\phi}\right)^{-1/\sigma}}{\theta - g(1-1/\sigma)}\frac{1-\alpha}{\alpha\varepsilon}E(N)N^{\phi}\left(\frac{\alpha(1-\varepsilon)}{1-\alpha}+\varphi\right)\left\{1+(\phi-\eta_{EN})\eta_{N\tau}\right\} + \frac{\partial W}{\partial g}\underbrace{\frac{dg}{d\tau}}_{\textit{growth effect}} \tag{5}$$

As illustrated in Fig. A11, note that maximizing growth is not equivalent to maximizing welfare, and the first term in eq. (5) reveals the difference. The key parameters affecting this difference are the size of tax distortions (φ), the productivity of pollution relative to abatement knowledge (ε), and the differentiated additional effects of τ on welfare and environmental sustainability by $(\phi - \eta_{EN})\eta_{N\tau}$.

III. CARBON TAX SCHEME FOR GREEN GROWTH IN KOREA

3.1 Why-questions

How will we meet the difficult global challenges before us, while simultaneously improving people's lives and conserving the environment?

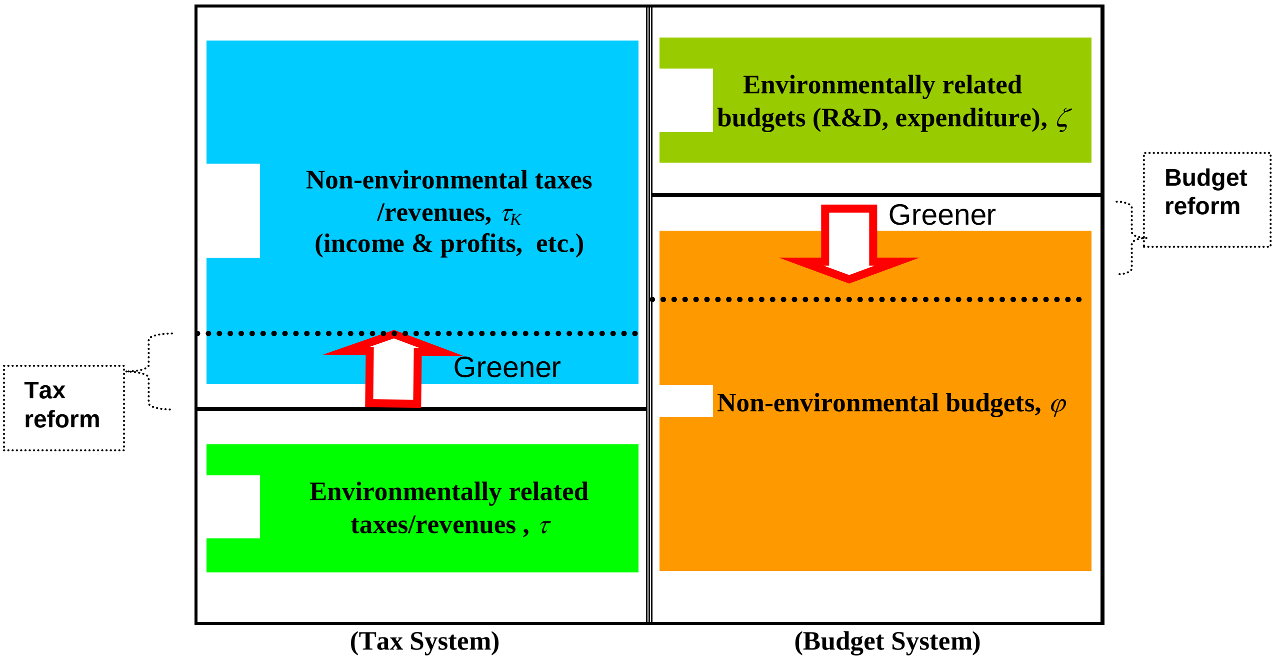
There is a widespread agreement on globally based efforts to investigate how to help the environment economically, with ultimate objective of stabilizing climate change. For practical purpose, environmental taxation becomes a credible choice in the ongoing policy discussion over how best to address global warming and to comply with implementing the President Lee's 'Low-Carbon, Green Growth' project.

Green Growth purports to achieve economic growth with generating enough jobs while preserving the limited ecological carrying capacity of the environment. Environmental Tax Reform (ETR), as partly illustrated in Figure 2, is the term used for changes in the national tax system where the burden of taxes shifts from 'goods', such as labor, capital or clean consumption to 'bads' such as activities that lead to environmental pressures. It is one of the key instruments to achieve the plan which would be both fiscally prudent and environmentally sound.

OECD countries have continued to increase and refine their use of environmental tax instruments for ETR since early 1990s. Countries in Nordic region including Finland (1990), then Sweden (1991) and Denmark (1993) were the first to launch such reforms, followed by the Netherlands (1996, 2001), Germany (1999) and the United Kingdom (1996, 2001 and 2002).

With its current draft, economic and environmental effects of ETR are quite positive. And some countries have shown considerable efforts in developing ETR in recent years. For example, environmental tax revenues have increased by about 36% since the launch of the German ETR in 1999. As part of the German program, about an additional EUR 20 billion was raised by energy taxed in 2003. The Swedish ETR contributes about 0.1% of GDP.

Figure 2. The Concept of Greening the Tax and Budget System



Taxes on motor fuels and motor vehicles have been rather stable as portion of total tax revenues generated about 90% of the revenue from environmentally related taxes in the European Union. They have designed taxes that target a broader array of tax bases, not only to reduce CO_2 emissions but also to cope with air pollution, noise levels and traffic congestion, including plastic bags, landfill waste, aggregates, batteries and pesticides.

For example, Table 2 provides an overview of the use of environmental taxes and charges in OECD countries. There are proven cases of eco benefits for each type of instruments. Taxes and charges have proved effective as shown by congestion charging in London, road-user charging for heavy goods vehicles in Switzerland, NOx (Nitrogen Oxides) taxes on air pollution in Sweden, and plastic bag levies in Ireland. Tax differentials were of major importance for unleaded fuel.

Some policy instruments are not feasible without suitable monitoring or administrative capacity. And there is no single recipe for a successful and effective tax scheme. Different factors determine the functioning of the specific schemes, each in their own context.

Examples include the Danish waste-disposal tax (high tax rates), the Norwegian pesticide tax (tax rates differentiated according to toxicity), the London congestion charge (strong champion; rather high charge), and Irish plastic bag tax (awareness of the advantage and simplicity of alternative behavior).

Table 2. Examples of Environmental Taxes

Eco Tax	Country	Remarks
Energy and CO_2	-Norway : CO_2 tax -Germany: Energy tax	-2% reduction in CO_2 emission -Increase in the world price of oil
Air Pollution	-Sweden: NOx charge	Unique example
Agricultural input	-Norway: Tax on pesticides	
Product	-Ireland: Plastic bag levy	Reduction around 90% of carrier bags
Waste	-Denmark:: Waste tax -UK: Landfill tax	-Reduction in waste
Water	-Netherlands: Wastewater effluent chares -Denmark: Tax on tap water	-Water Pollution decrease 90 % -26% reduction in total water consumption
Transport	-London, UK: Congestion charge -Switzerland: Road-user charges	-Reduced congestion in zone / Increased interest from other countries

Sources : OECD/EEA database on environment-related taxes, Ministries of Finance and Environment of the European countries

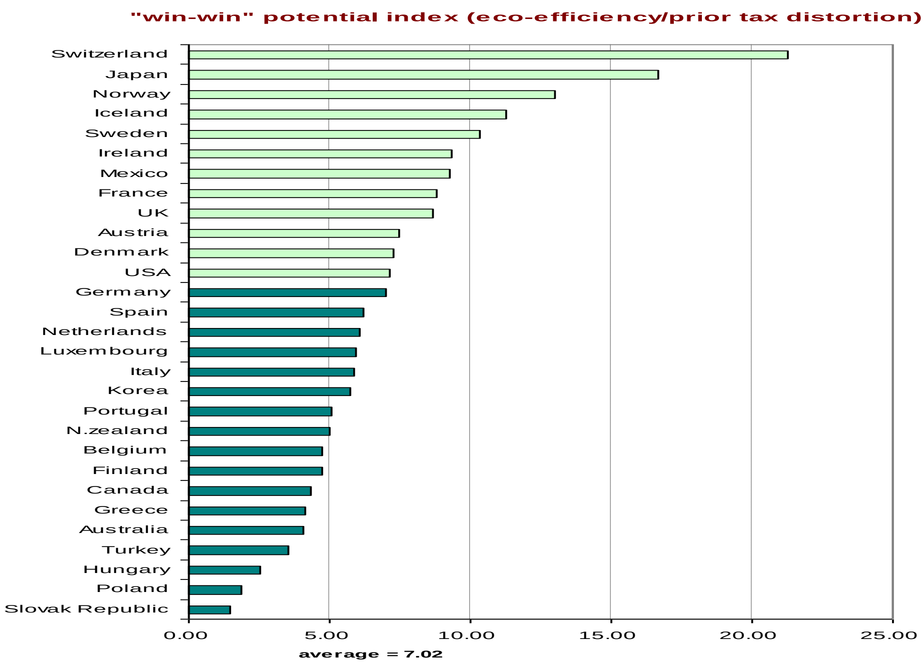
The positive effects of ETR are the reduction of energy consumption, the decrease of CO_2 emissions, the diversification of energy sources, the creation of specialized employment, and the promotion of green technologies.

One negative short-term impact is on heavy energy users such as fossil fuel electricity and steel industry. Undoubtedly, the eco tax reform would be more effective and the impact on international competitiveness would be smaller if more countries participate or take equivalent measures.

My own analysis of the ‘green-growth potential indicator’(or “win-win” potential index) shows that green growth relies crucially on the degree of prior tax distortions and eco-efficiency. Here the “win-win” potential index is defined as the ratio of eco-efficiency to prior tax distortion for each country as an illustration.

Figure 3 indicates that Korea’s “win-win” potential index is ranked to 18th in 30 OECD countries. The Korea’s “win-win” potential index is 5.74 that is lower than the OECD average 7.02, and it is well behind to some cases of Switzerland(21.25), Japan(16.64), Norway(12.97), United Kingdom(8.70) and US(7.16). This is mainly due to industrial production structures and people’s consumption patterns that are still not energy-efficient and environmentally unfriendly in Korea.

Figure 3. The “Win-Win” Potential Index : The Case of Global Warming



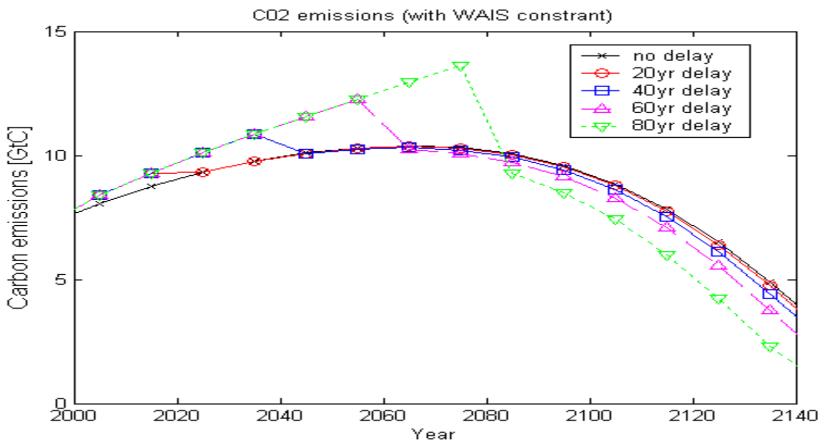
Source: Kim, S.-R. (2005), First Regional Policy Dialogue, UNESCAP International Conference, p.157.

3.2 When-questions

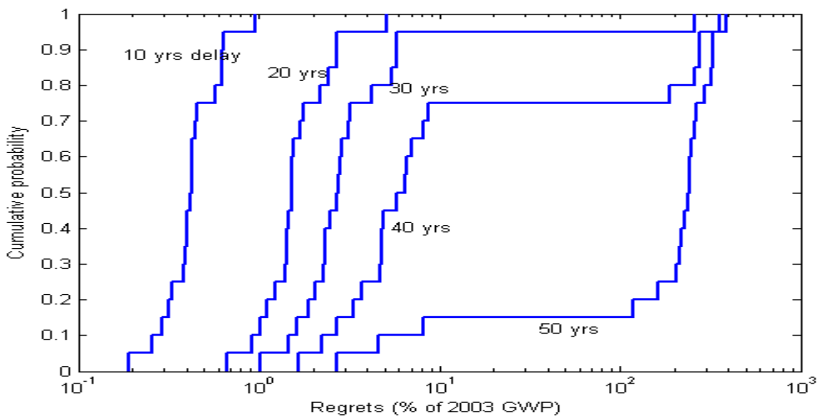
The more we delay, the more we pay.

How much we lose if we delay optimal fiscal policies for ecologically sustainable development? In case with a climate sensitivity of 3.4 (i.e., the degree of 3.4 ^{0}C temperature increase of doubling CO_2 concentration), my own calculation, using Nordhaus-Boyer DICE model, indicates that the cost of regrets by 10-years delay amounts to about 4% of Gross World Product, which wipes out South Korea's GDP in 2000.

Figure 4. Distribution of "Regrets" as a function of Procrastination



(a) Carbon reduction schedule



(b) Regrets of prograstination

Here, the “regrets,” as a social cost of procrastination, is approximated by the net-present value of the future consumption losses of optimal policies “with each specific procrastination constraint” relative to “without procrastination activities”.

This result reveals that, even with uncertainty, the “regrets” are not negligible but significant. Figure 4 implies that the endogenously calculated possibility and risk of probabilistic regrets can increase substantially with the years of procrastination.

Not only developed countries but also developing countries and economies in transition need to actively take part in shifting to more eco-efficient production and consumption patterns.

Compared with other countries, Korea’s ecological footprint was short as calculated by the UN Environment Program. The increasing rate of carbon emission in Korea is one of the highest around the world due to the high degree of dependence on heavy and chemistry-based industrial structure. Also, lack of understanding of energy savings makes our energy efficiency less competitive.

3.3 How-questions

The Korean government is now mulling the introduction of a carbon tax, which taxes the combustion of fossil fuels according to their carbon contents.

The implementation of a carbon tax has to be met by increasing energy efficiency and using low-carbon energy sources which would reduce CO_2 emissions, and it could provide more explicit price signal for firms to promote the development of new emission-reduction technologies.

The taxation of energy in Korea has been earmarked mostly for transportation infrastructure so far and still allowed for tax reductions and exemptions for most energy-intensive sectors, undermining seriously its environmental effectiveness. For example, the earmarked "transportation-energy-environment tax" (which is subject to a 2012 clause) would need to be converted an individual consumption tax so as to increase the allocative efficiency and the flexibility of government spendings.

Table 3. Energy Taxation in Korea (2010. 1)

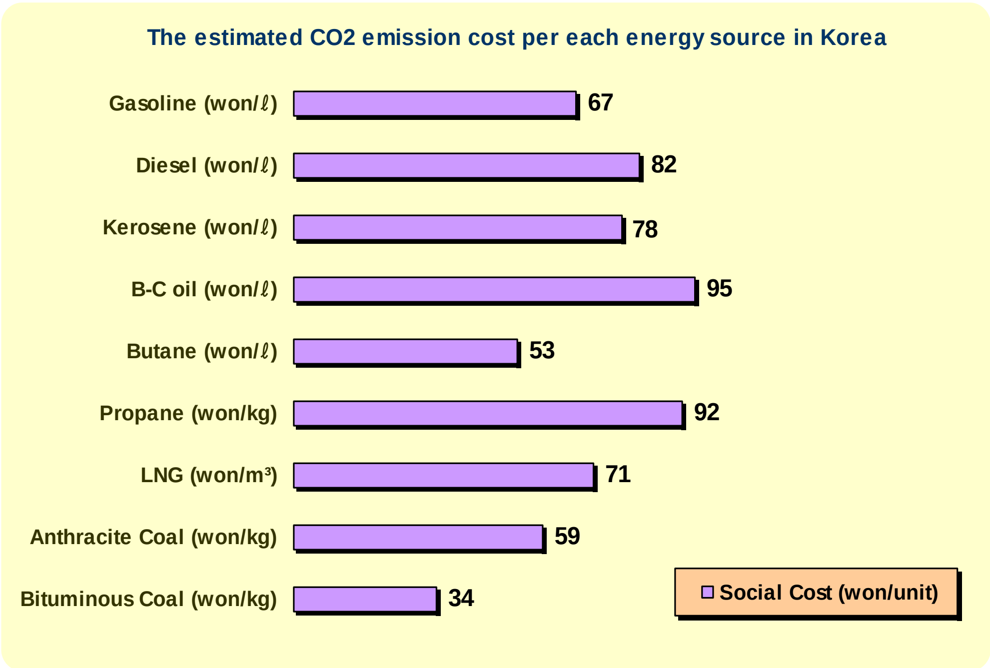
		Gasoline (won/ℓ)	Kerosene (won/ℓ)	Light oil (won/ℓ)	Heavy oil (won/ℓ)	LPG (won//kg)		LNG[1] (won/m^3)
						propane	Butane	
Customs Tax	General	5%				3%		3%
	Quota (Provisional)	3%				2%		2%
Individual Cons. Tax	General	-	90	-	17	20	252	48
	Flexibility	-	63	-	-	14	275 (161 won/ℓ)	
Trans. Energy Environ. Tax	General	475	-	340	-	-	-	-
	Flexibility	529	-	375	-	-	-	-
Education Tax[3]		79	14	56	3	-	41 (24 won/ℓ)	-
Local Drive Tax[4]		138	-	98	-	-	-	-
VAT		10%						
Import Fee		16				-		19.58
Quality Examination Fee		0.430				0.027		-
Safety Management Levy		-	-	-	-	4.5		3.9
Sales Levy		36 (High)	-	-	-	-	62.283 (36.42 won/ℓ)	-
Total Tax Amount	Amount	897	198	661	87	184	527 (308 won/ℓ)	120
	Price Share Ration	54%	19%	46%	12%	10%	32%	15%
Consumption Price		1,661	1,040	1,450	744	1,808	1,636 (957 won/ℓ)	783

Source: Ministry of Strategy and Finance(2010)

Based on experience in OECD countries, Korea should shift more some of tax burdens from income to energy, while addressing properly their potential impact on international competitiveness and distributional concerns. To do this, the Korean government needs to consider further the full environmental costs and other external costs in setting tax rates on energy, phasing out various exemptions and environmentally harmful subsidies, and introduce a carbon tax to curb CO2 emissions in the near future.

According to the analysis of McKinsey's Antonio Volpin and Cambridge Econometrics in UK, the average market price per ton of CO_2 emission trading is estimated to 25 EUR (= 31,828 KRW in 2007) from 2008 to 2012. Following this, Kim et al.(2008) suggest a carbon tax scheme for Korea in Figure 5, as the rate of emission cost per each energy source can be measured by multiplying the price 31,828 won and the unit amount of CO_2 emissions. [9]

Figure 5. The Estimated CO_2 emission Cost per Each Energy Source in Korea



[9] Rates of tax rates are defined separately for each energy sources, and relative tax levels on different energy sources are set so as to equate the implicit rate of tax per unit of CO_2.

However, cutting CO_2 emissions would involve costs that are uncertain but could be substantial. As in Table 4, a "gradually rising" tax, starting with a "low-rate" carbon tax of 2.94 EUR per ton of CO_2, *e.g.*, 1 trillion KRW tax revenue (= 0.1% of GDP), would allow for a smoother transition to a less carbon-intensive economy and could be more politically-feasible. Businesses and households would have more time to replace their equipment and energy-use practices with more efficient alternatives.[10]

Table 4. Proposed Carbon Tax Schemes on Energy Consumption in Korea

Energy sources		Gasoline (won/ℓ)	Diesel (won/ℓ)	Kerosene (won/ℓ)	B-C oil (won/ℓ)	Butane (won/ℓ)	Propane (won/kg)	LNG (won/kg)	Bituminous. coal (won/kg)
Energy taxation (excl. VAT)		745	528	104	20	185	20	60	Exempted
Carbon taxation	Social Cost (ideal)	67.5 (4.4%)	82.4 (6.5%)	**77.7** (8.29%)	95.5 (19.4%)	**53.2** (6.9%)	**92.0** (6.9%)	**71.0** (11.1%)	**33.7** (45.6%)
	Low-Rate (realistic)	**8** (0.5%)	**10** (0.8%)	**9** (1.0%)	**11** (2.3%)	**6** (0.8%)	**11** (0.8%)	**10** (1.3%)	**4** (5.3%)

Note: 1) Numbers in parenthesis represents increase in prices for each energy products by carbon taxation
2) Scenarios for carbon taxation of 'Social Cost' and 'Low-Rate' are assumed to raise 8.9 tril. KRW and 1.0 tril. KRW of tax revenues respectively.

From experience in countries that have already implemented eco tax reform in Europe, we may need a gradual phasing-in of the reforms and enhance the use of a public information campaign for stronger incentives and political feasibilities. UK's fuel duty escalator can be a good example as a slow but sure way of making policy instruments more demanding and effective.

Moreover, implementing a new carbon tax system (energy-carbon tax or elements of carbon tax in a broader tax system) would have scope for reducing more distortive other prior taxes in Korea such as corporate income taxes. It could be also used to increase tax benefits for various corporate investment and R&D efforts in carbon reduction activities.

[10] The proposed carbon tax rates would need to be raised in line with inflation (or GDP growth rate) every year to maintain the environmental incentives of the tax.

The Korean government could introduce a new energy-carbon tax in 2013 to partly offset public budget deficits from its scheduled, consecutive corporate income tax cuts (*e.g.*, the size of carbon tax revenue, 0.1 – 0.3% of GDP). Introducing carbon tax would help cut emissions and stimulate clean technology investment**.**

In fact, eco tax reform would lead to increased competitiveness as a result of fiscally neutral and net positive effects on employment due to the decrease of more distortive taxes on income and the promotion of innovation of new green R&D technologies.

Relative to other non-revenue-raising environmental instruments that achieve the same goals, carbon taxation could have positive economy-wide effects depending on the methods of recycling the tax revenues.

For example, a policy simulation using a dynamic computable general equilibrium model(DCGE) by Kim et al.(2010) shows that the overall “positive” effect on economic efficiency(GDP) would be significant when implementing a new carbon tax scheme from 2013 together with corporate income tax(CIT) cuts and eco-R&D subsidies in Korea (see Figure 6). [11]

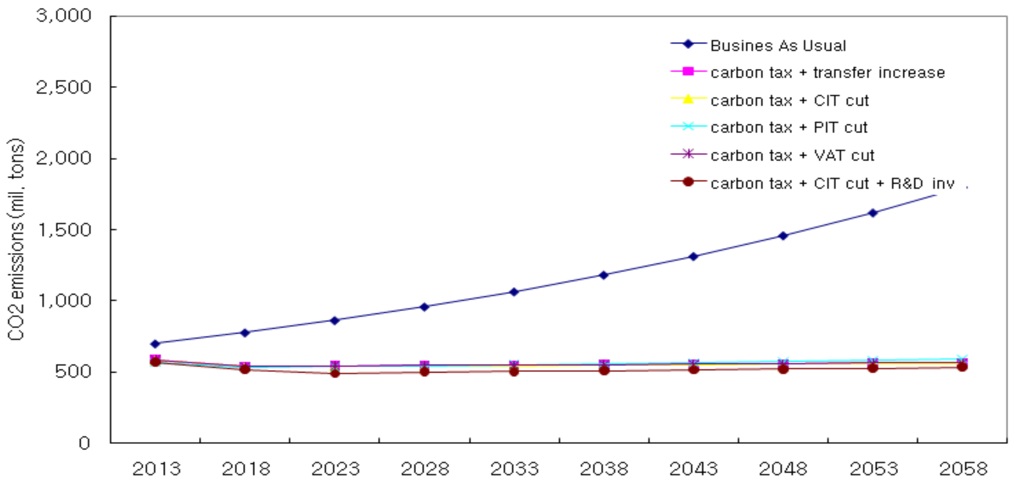
The Korean government is also pushing for other policy instruments such as Negotiated Agreement(NA) system and Cap-and-Trade system. Under the new NA system in 2013, companies will negotiate binding agreement with the government on energy use and greenhouse gas reduction targets. If businesses fail to meet the targets, they should pay penalties such as correcting mandates and fines. Also, based on the Comprehensive Act on Green Growth, the government is planning to introduce a Cap-and-Trade system for CO_2 permits in 2015.

This is time for setting up the Korea’s Eco Tax Reform with a view to our future development and it should also reflect more closely the sustainable issue being addressed.

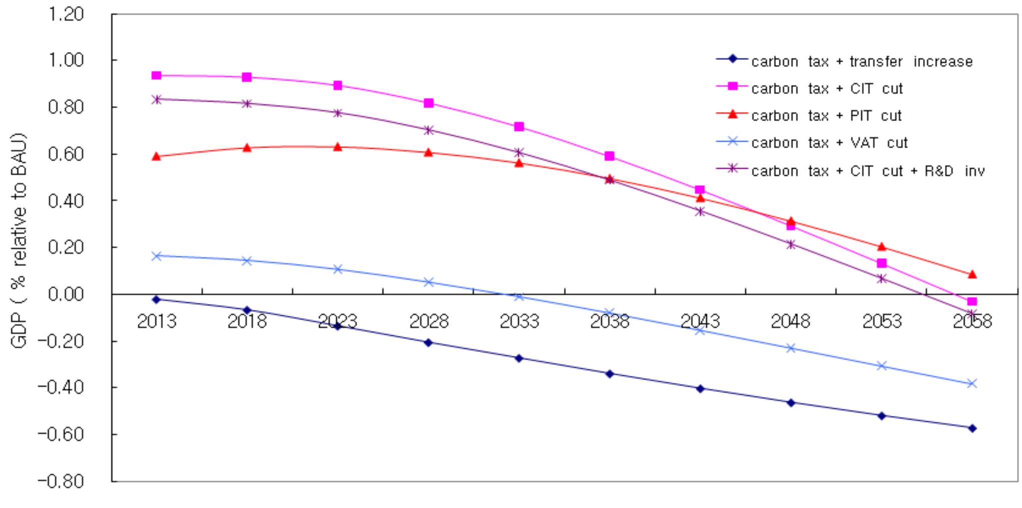
[11] For technical details of the model structure, see Kim et al. (2010).

On the early stage of implementing eco tax reform in many countries, there were concerns about losing international competitiveness of industries and business association.

Figure 6. Efficiency Effects of Alternative Revenue-recycling Schemes from Carbon Taxation in Korea : 25 EUR Case



(a) CO_2 emissions



(b) GDP

However, as regards of impact of the scheme has been successful through performing with clear goal and collecting public opinions. In Germany it could achieve by differentiating tax rates and making special provisions for vulnerable groups. So that private households and small businesses are those who are unlikely to pay high rates. In UK, there has been extensive consultation with business and designed in a way that protects the competitiveness of UK firms. UK industries and businesses receive a 80% discount to Climate Change Levy (CCL) in return for Climate Change Agreements(CCA) to meet energy efficiency and/or carbon emission targets.

It is also important to devise appropriate compensation fiscal schemes for the poor households group. Applying new environmental taxes in full, combined with compensation schemes for the poor, would be the role of environmental taxation. OECD recommends ex post direct compensations rather than ex ante tax exemptions of this purpose.

Table 5. Distributional Effects of Carbon Taxation in Korea : The 'Low-Rate' Tax Case

(2007 Year, Thousand KRW)

Income deciles	1(Poorest)	2nd	3st	4th	5th	6th	7th	8th	9th	10(Richest)	Aver-age
Burden on Non-energy products(A)	8.04	10.04	12.05	13.98	15.54	17.64	19.41	20.69	24.04	34.69	17.68
Burden on Energy products(B)	10.69	13.20	17.65	19.16	20.80	22.74	24.08	26.79	28.45	35.82	22.24
Coal	0.87	0.60	0.41	0.65	0.40	0.55	0.33	0.19	0.33	0.20	0.47
Petroleum	4.46	5.95	8.86	10.15	11.75	13.08	14.28	16.12	17.38	23.13	12.67
Gas	3.31	4.29	5.68	5.74	5.87	6.26	6.61	7.33	7.40	8.48	6.18
Electricity	2.05	2.35	2.69	2.61	2.78	2.85	2.87	3.16	3.34	4.02	2.92
Total burden (A+B)	18.73	23.24	29.69	33.14	36.34	40.38	43.49	47.48	52.48	70.52	39.92

Note: ‘Low-Rate’ scenario of carbon taxation is assumed to raise 1.0 trillion KRW of tax revenue (= 0.1% of GDP). Gini coefficient relative to income slightly increases by 0.0403% from 0.3408 before tax to 0.3410 after tax.

For the 'Low-Rate' carbon tax scenario in Table 4, the negative effects of the new tax on income distribution would be minimal. Using the method of a general equilibrium incidence analysis by Wier et al.(2005), my own calculation on carbon tax incidence in Korea indicates that the low-rate carbon tax would be not significantly regressive(see Table 5). In this case, only small amount of additional revenue from carbon taxation can be used to provide higher transfers to poorer households to at least leave them no worse off. In the case of this 'Low-Rate' scenario, the benefits from carbon taxation would largely depend on how the revenue is spent rather than how it is raised.

3.4 Other Considerations

It is important to maintain transparency and ensure the participation of businesses and local people in the planning and use of the tax which can defuse potential opposition to a new environmental tax charge.[12]

Public would be more inclined to support new carbon taxes if the tax revenues are used to fund a broader package of measures such as environmental projects and/or enhanced capital allowances for investment certain energy-saving /green technologies. It could help gain industry buy-in and reduce the cost of business arising from carbon taxation.

For Korea, the carbon tax scheme would need to designed alongside a broader fiscal package of measures (notionally funded from carbon tax revenues) in order to protect the international competitiveness of firms. For instance, energy-intensive industries could receive a discount to the proposed carbon tax rates in return for joining a successful NA programs to improve energy efficiency and/or reduce emissions to specific levels.

Hypothecation of part of carbon tax revenue to subsidize green projects in industries and/or low-income families could also raise public acceptability of new carbon taxation.

[12] In this respect the problem of implementing a new carbon tax is often political issues rather than economic issues.

Knowledge transfer between countries (e.g., via GGGI) about the use of economic instruments in environmental policy would be desirable, whereby country-specific conditions are being considered when such a transfer is done.

IV. CONCLUDING REMARKS

Current energy tax system in Korea is not sufficient for fostering low-carbon, green growth. In some parts, the government is subsidizing environmentally-harmful behaviors such as fossil fuel consumption, while considering imposing carbon taxes on those same behaviors later on.

It is time to take concrete measures to implement the national green growth strategy. One of such measures will be to introduce a carbon tax in the near future. It is also important to invent “smart” ways of recycling the carbon tax revenues to achieve its voluntary CO_2 reduction target and provide technological momentum for “green growth” development. The introduction of the tax scheme would be a starting point for the nation's campaign to increase energy-efficiency, combat climate change and promote nation-wide green technologies.

The government needs to formulate “smart” taxation and fiscal schemes to promote, rather than thwart, innovation for low-carbon, green growth. So, green tax commissions’ or ‘inter-ministerial committees’ for national eco-tax reform should also be emphasized. They can make detailed and more realistic proposals for mid- and long-term environmental tax reform in Korea and act as a forum for discussion on topics that include design, rates and the likely impacts. Analyzing and recommending to reform by political parties and academic and institute circles can be available.

More attention needs to be paid to increase the knowledge of designing environmental tax schemes with continued research and development.

In implementing the appropriate eco tax reform, it is necessary to weigh partly conflicting demands against each other for energy-intensive sectors, ecological effectiveness, economic efficiency, compatibility with market principles and issues of administrative feasibility. Such a balance must be determined politically in order to reduce uncertainty about future development.

There are still ways to go, even though government got off to a first step to eco-sound fiscal policies. Compared with other OECD countries, Korea has less energy-efficient industrial structures with complicated fiscal policies and large differences of tax burdens on each energy-demanding sectors.

Table 6. Example Roadmap for Eco Tax Reform in Korea (2010-)

Policy Instruments	**Plans**						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2020**
Eco tax Reform (including energy-carbon taxes and elements of carbon tax)	Prepare/ Phase-In			Full			
ETS (Cap and trade)	Prepare/ Phase-In					Full	
V.A or N.A.	Prepare/ Phase-In	Phase I		Phase II			
Compensation for Key Industries' competitiveness	Prepare/ Phase-In			Full			
Pro-poor policies (redistribution)	Prepare/ Phase-In			Full			

Therefore, Korea is now facing to prepare for the post-Kyoto scheme which would enforce to find a new paradigm for dealing with environmental sustainability and economic growth. In order to implement the Korea's new scheme successfully, a key theme "green taxes" would be essential to provide greater efficiency gain through helping to 'get the prices right' associated with their environmental externalities.

Further, it is required to consider secondary instruments such as direct compensation payments, price support and tax exemptions for unfair burdens of low-income households and more energy-vulnerable sectors. All those approaches might be offset of distributional consequences as mitigating the harmfulness of eco-motivated fiscal policies.

It's pretty obvious that the more we delay action, the more cost we pay. If we invest green technology in recent economic slowdown, we will have a global initiative that would make our economy more competitive in the long run.

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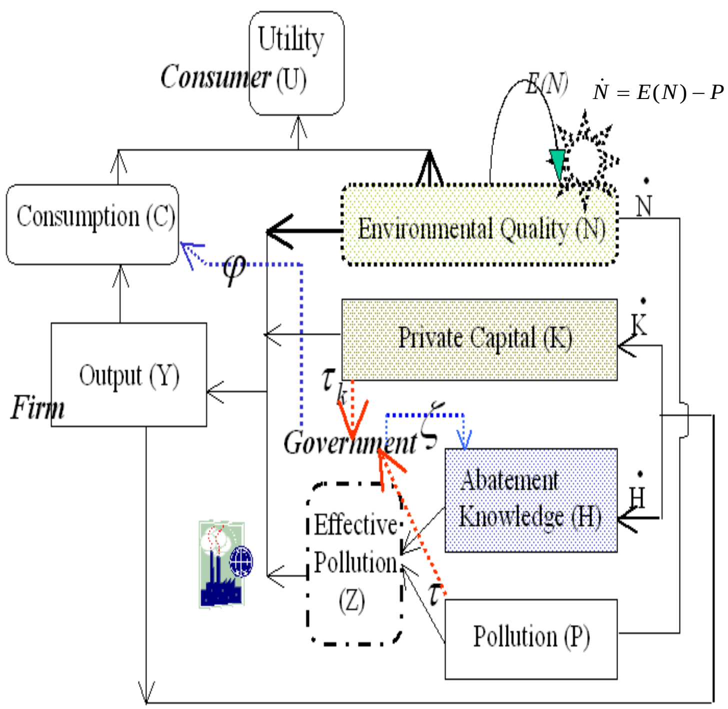
APPENDIX

The “Green” Growth Model (Fullerton and Kim, 2008)



Endogenous Variables

- Utility (U)
- Consumption (C)
- Output (Y)
- Environmental Quality (N)
- Private Capital (K)
- Abatement Knowledge (H)
- Pollution (P)
- Effective Pollution (Z)

Key parameters

- Environmental preference (ϕ) — Preferences
- Elasticity of intertemporal substitution (σ) — Preferences
- Time preference rate (θ) — Preferences
- Environmental productivity (γ) — Technology
- Pollution-conversion factor (ε) — Technology
- Output elasticity of abatement knowledge (á) — Technology
- Ecological capacity factor (β) — Ecology
- Degree of prior tax distortion (φ) — Others (tax system, etc.)

Policy instruments

- Pollution tax (τ_p) — Policies
- Private capital income tax (τ_K) — Policies
- Public investment in environmental R&D ($\dot{H}$) — Policies

Fig. A1. Diagram of Greening the Tax and Budget System Towards Sustainable Economic Growth

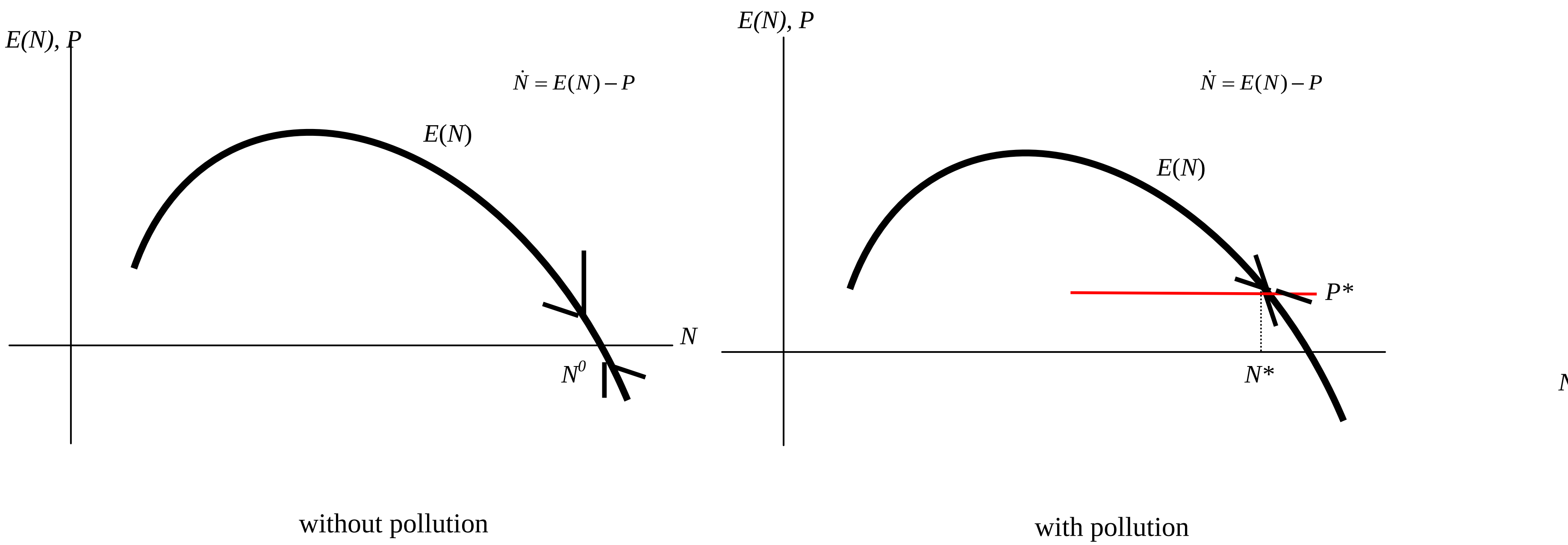


Fig. A2. The Regeneration of the Environment. 'Sustainable development' ($\dot{N} = 0$) requires that pollution P is constant in the long run and does not exceed the maximum absorption capacity. Due to the concavity of $E(N)$, two levels of N may have $\dot{N} = 0$. One has low N with $E' > 0$, and the other has high N with $E' < 0$. With a constant level of pollution P, only the latter equilibrium is stable, so this study focuses on that case. For more details, see Neher (1990), Tahvonen and Kuuluvainen (1991), and Bovenberg and Smulders (1995, 1996).

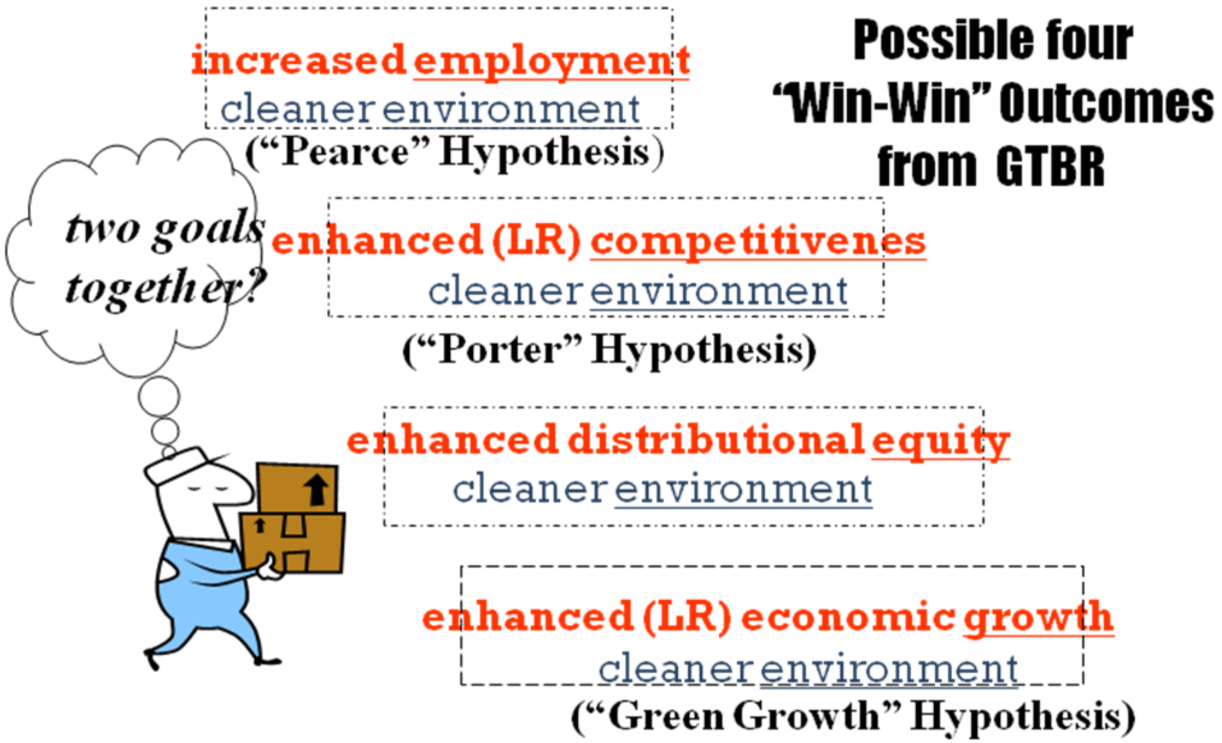
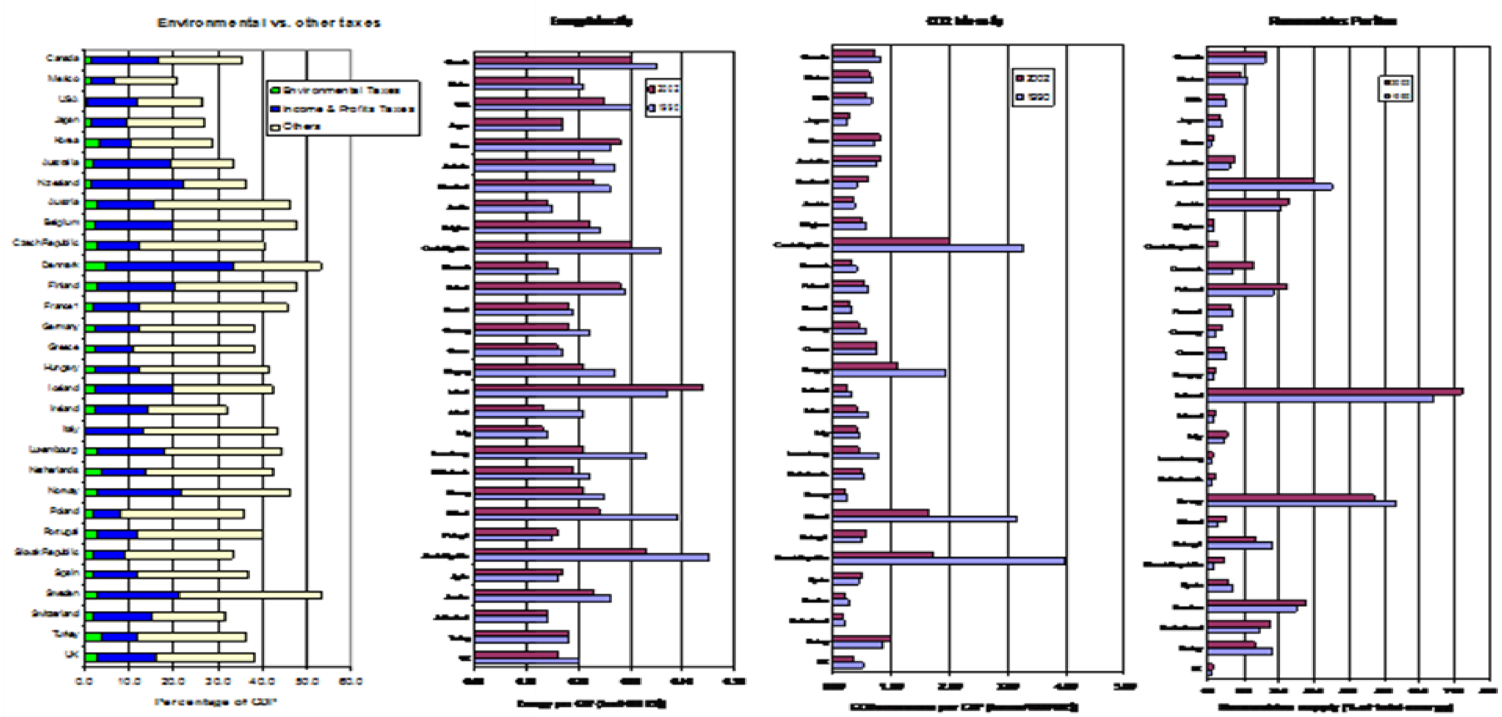
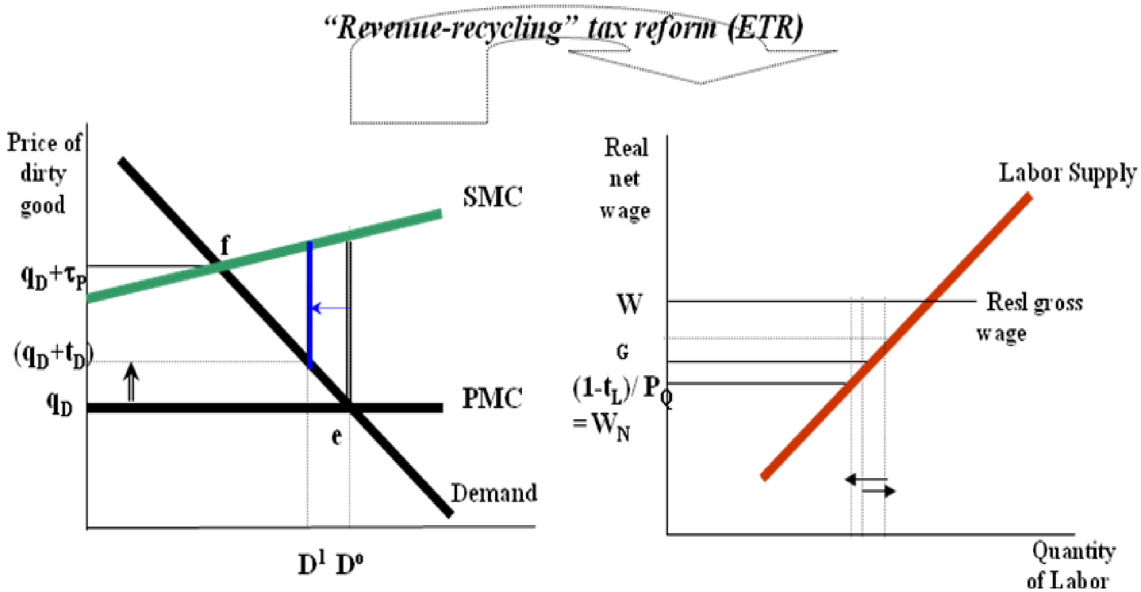


Fig. A3. Possible Win-Win Outcomes from Green Tax and Budget Reform (GTBR)



(a) (b) (c) (d)

Fig. A4. Comparison of OECD countries: Tax Structure, Energy Intensity, CO2 Intensity, and Renewables Portion



where environmental tax rate = $t_D M = \left[1 - \left[t_L/(1-t_L)\varepsilon^U\right]^{-1} - 1\right.$

labor tax rate = t_L

marginal environmental damage = $\tau_P (\equiv MED)$

uncompensated labor supply elasticity = ε^U

Fig. A5. Graphical Illustration of Eco Tax Reform (ETR) from Income Tax to Energy Tax

- Pearce (1991): Environmental taxes might offer a so-called "double dividend (DD)" (*i.e.*, these taxes not only **improve the environment** but might also **reduce welfare costs** of the overall tax system).

=> Related question: "*Whether the optimal environmental tax in a second-best world* ***lies above or below*** *the social marginal damages(MED)*?" is the cornerstone of much recent literature.

- **Earlier view (optimistic DD):** The second-best optimal pollution tax would be *higher than* necessary just to correct the externality(=*MED*).

  e.g., Tullock (1967), Terkla (1984), Lee & Misiolek (1986), ***Pearce (1991),*** *Repetto et al (1992), Nordhaus (1993)*

- **Recent studies (pessimistic DD):** Environmental taxes typically *exacerbates* pre-existing tax distortions and, therefore, the optimal pollution tax should lie *below* the Pigouvian level (≡ social marginal damages) – the critical role of "***pre-existing tax distortions***" and negative "***tax interaction***" ***effects***

  e.g., ***Bovenberg and de Mooij (1994)****, Goulder(1995), Parry(1995), Oats(1995), Fullerton(1997), etc.*

- **More recent studies (mixed DD, but generally optimistic):**

  The prospects of DD depends on various parameters on the structure of preferences and technology (e.g., degree of relative complementarity of taxed dirty good w.r.t. leisure, ϕ ; demand elasticity of taxed dirty good, ε_D etc.) or "Whether the second-best pollution tax (t_D*) should be greater (or less) than the first-best pollution tax ($\tau_P \equiv$ MED)" depends on the following many factors (e.g., MED, prior income tax rates (t_L), tax rate on scarcity rents by non-auctioned permits((t_Π) , and some key elasticities in related markets, etc.)

  e.g., ***Kim (2002), Bovenberg and Goulder(2002), West and Williams(2004)****,Ballard et al.(2005), etc.*

=> *Generalized second-best environmental tax rules (Kim, 2002)*

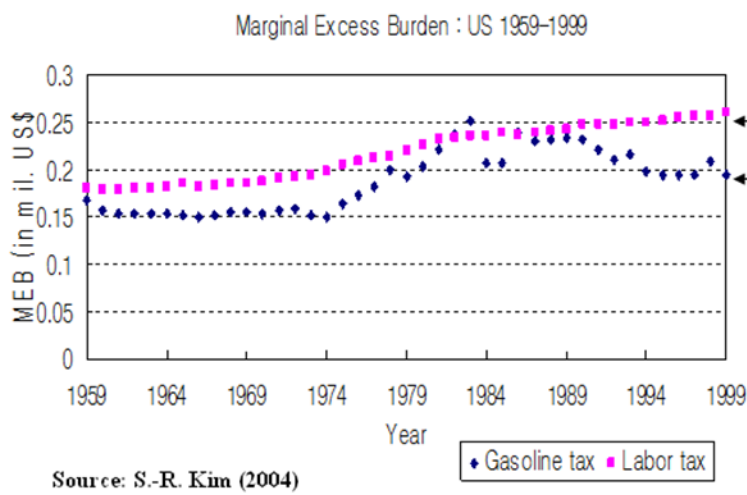
$$t_D^* = \frac{\tau_P (or\ MED)}{\left[1-\left[t_L/(1-t_L)\varepsilon^U\right]^{-1}\left(\dfrac{\varepsilon_D-\phi}{\varepsilon_D}\right)\right]}, \text{ or } \quad t_D^* = \frac{\tau_P (or\ MED)}{(1+t_\Pi M)\left(1+\dfrac{M(\phi-t_\Pi)}{1+t_\Pi M}\right)\dfrac{1}{\varepsilon_D}} \text{ with non-auctioned permits}$$

where $M = \left[1-\left[t_L/(1-t_L)\varepsilon^U\right]^{-1}-1\right.$ is marginal excess burden of prior income taxes.

Fig. A6. The Literature on ETR and employment: "Weak" form of Green Growth (I)

Example: Comparing Marginal Excess Burden (MEB)

Gasoline vs. ***Labor***



sample average

Labor tax: 0.2175

Gasoline tax: 0.1882

$$MEB_i(p^1, p^0, W^1) = \frac{\partial W(p^1, p^0, W^1)/\partial t_i}{\partial R(p^1, p^0, W^1)/\partial t_i}$$

Source: S.-R. Kim (2004)

"This implies the modest possibility of <u>social welfare gains</u> from tax reforms that that <u>shift</u> some of the burden of taxation off <u>labor</u> onto <u>energy</u> (e.g. gasoline)"

`

Fig. A7. Comparison of Marginal Excess Burden : Energy vs. Labor Taxes

Can tighter environmental regulation or taxes boost economic growth (*i.e.*, Green Growth, GG)? If so, when?

<***Two contrasting views***>

- **Exogenous Growth Models (Ramsey-style, Solow): pessimistic GG**
  - Technical change is modeled as "exogenous" parameter.
  - Optimal Pollution control hurts growth by raising abatement costs.

  e.g., Jorgenson & Wilcoxen(1990), Xepapadeas(1993), Tahvonen & Kuuluvainen(1993), Nordhaus(1994), Goulder(1995), Nordhaus & Boyer(1999), etc.

- **Endogenous (or New) Growth Models (Romer, Lucas, Barro, Rebelo, etc.): optimistic GG**
  - Technical change becomes additional "endogenous" variable (additional factor of production via investment in knowledge or technology)
  - Optimistic view on the growth-environment relationship (a tighter environmental policy may boost economic growth, at least in the long-run).

  e.g., Bovenberg and Smulders(1995, 1996), Elbasha and Roe(1996), Stokey(1996), Bovenberg and de Mooij(1997), Hettich(2000), Fullerton and Kim(2008), etc.

Fig. A8. The Literature on ETR and growth: "Strong" form of Green Growth (II)

- **Case 1: Conventional growth model (with *no* endogenous R&D accumulation)**

  - Tighter environmental taxes always hurt growth, since $\tau(g^{max}) \leq 0$

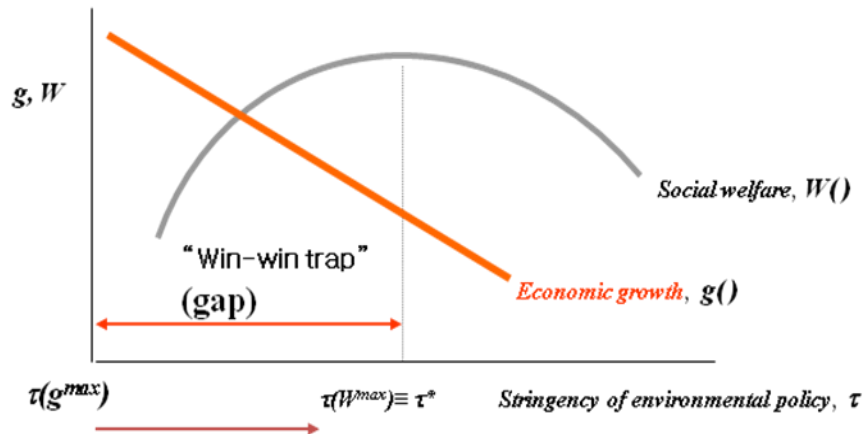
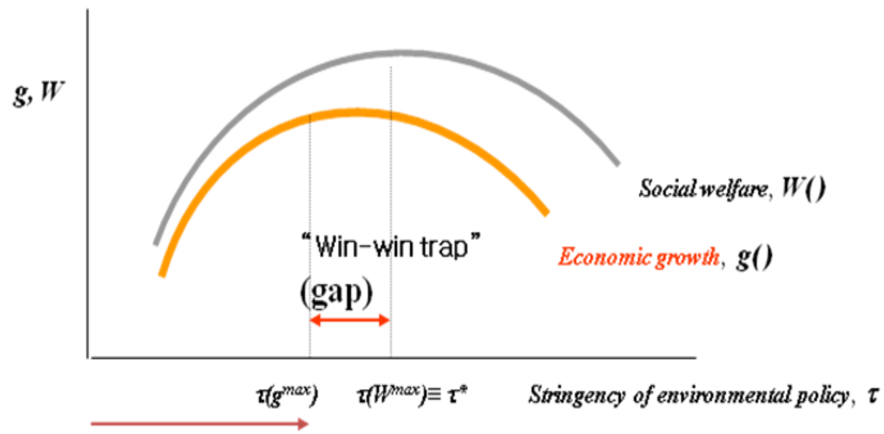


Fig. A9. Conventional View on ETR and growth

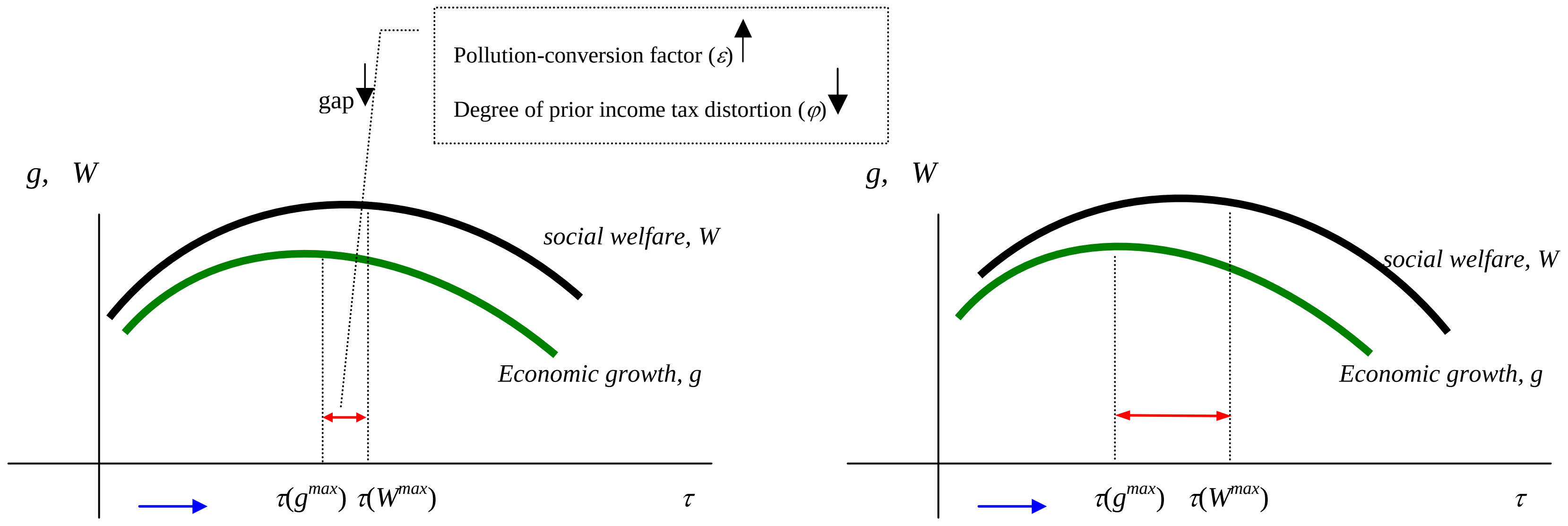
• **Case 2: a new GTBR framework (with *endogenous* R&D accumulation)**

- Tighter environmental taxes may boost growth until a positive $\tau(g^{max})$



Source: Fullerton and Kim (2006), p.21.

Fig. A10. New View on ETR and growth



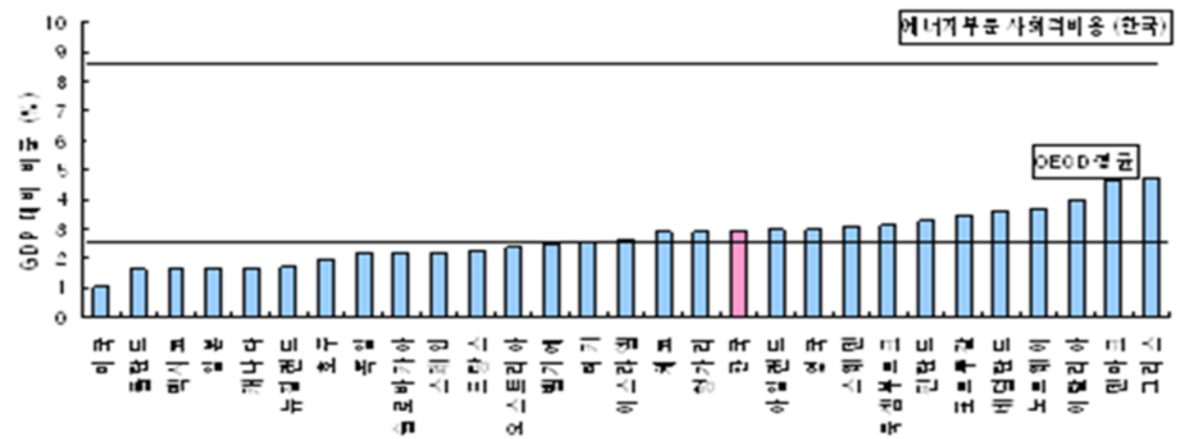
(a). Small gap: "win-win" is *highly likely*

(b). large gap: "win-win"is *modest*

Fig. A11. Optimal Environmental Policy for Green Growth

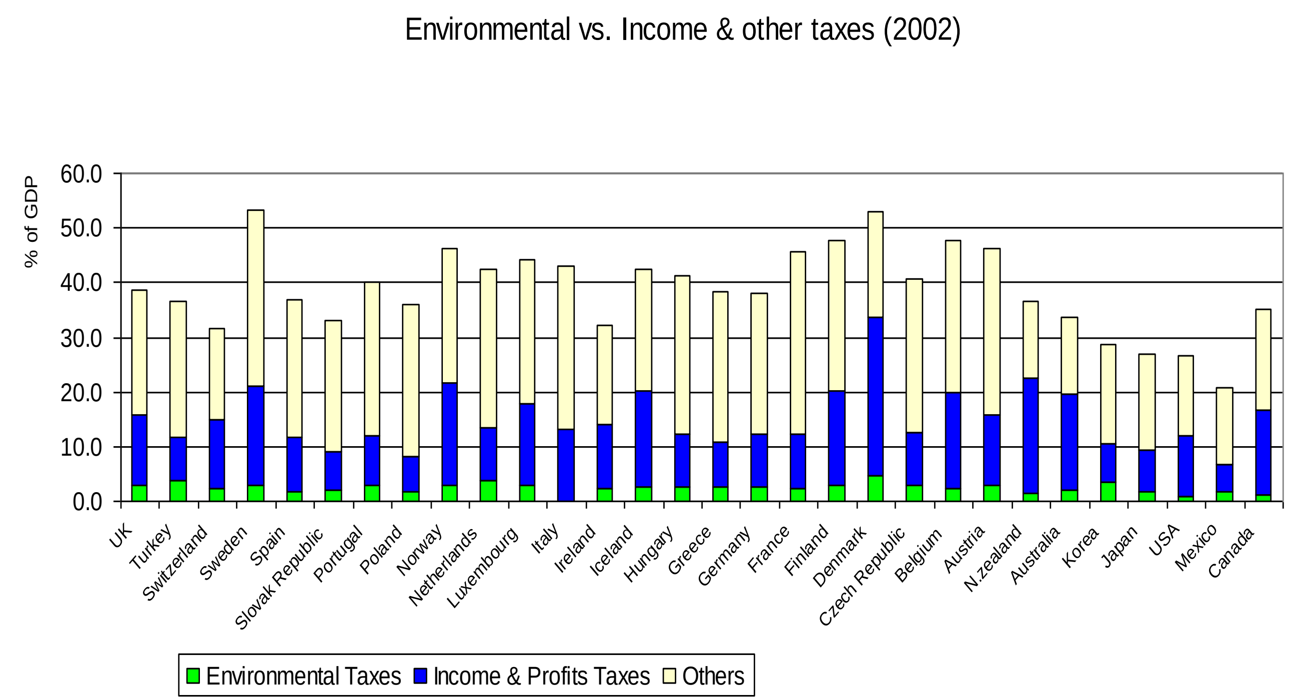
Denmark 4.65%, Norway 3.67%, Netherlands 3.63%, Filand 3.27%

> Korea 2.92% > OECD avg. 2.71%



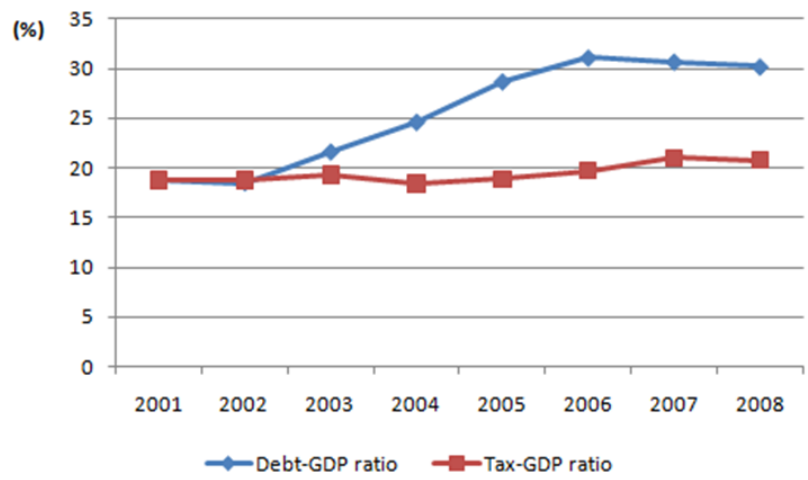
Source: Kim, S.-R.(2009)

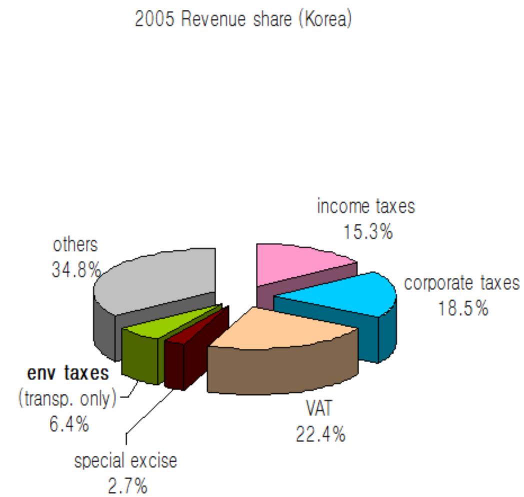
Fig. A12. Environmentally related taxes as percent of GDP (2005)



Source: OECD Revenue Statistics, 2007

Fig. A13. Environmentally related taxes vs. Other income taxes: International comparison

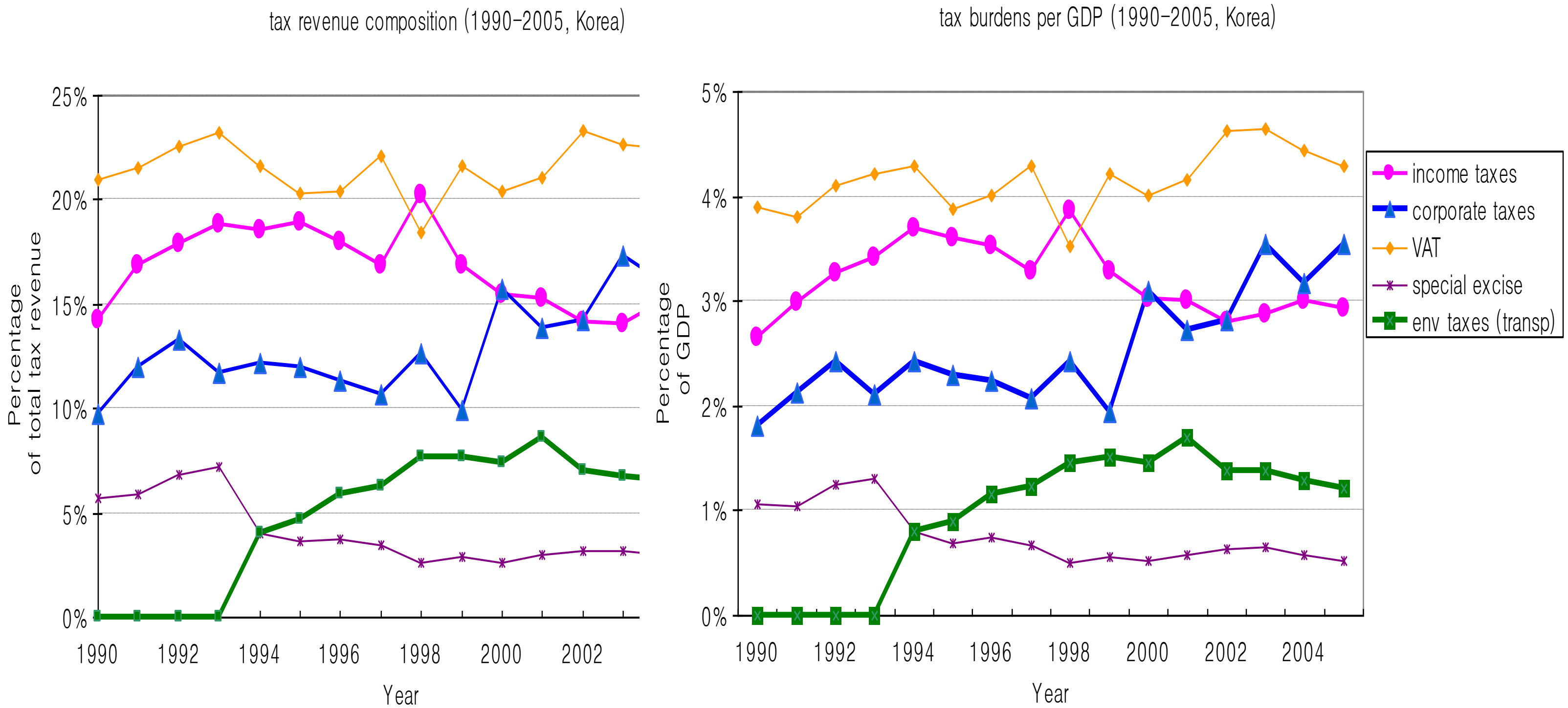




	2001	2002	2003	2004	2005	2006	2007	2008
National Debt (tril. Won)	122.1	133.6	165.7	203.1	248	282.8	298.9	309
Debt-GDP ratio (%)	18.7	18.5	21.6	24.6	28.7	31.1	30.7	30.2
Tax Revenue (tril. Won)	122.5	135.5	147.8	152	163.4	179.3	205	212.8
Tax-GDP ratio (%)	18.8	18.8	19.3	18.4	18.9	19.7	21	20.8

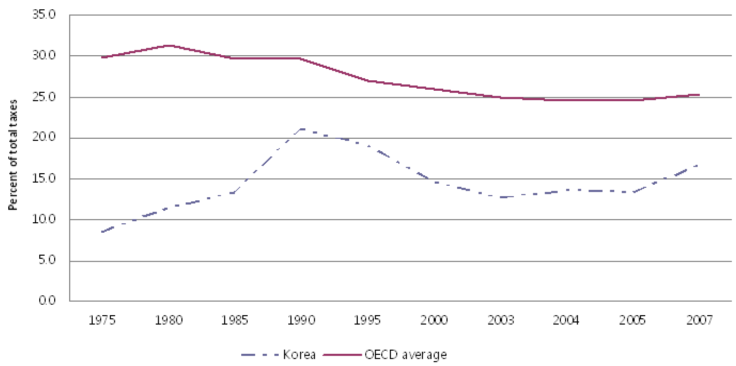
Source: MOSF(2009)

Fig. A14. National Debt, Tax Revenue, and Tax Structure in Korea

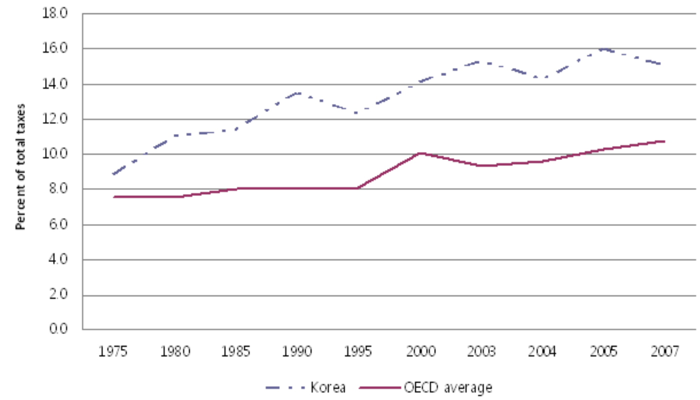


Source: NTS(2009), MOSF(2009)

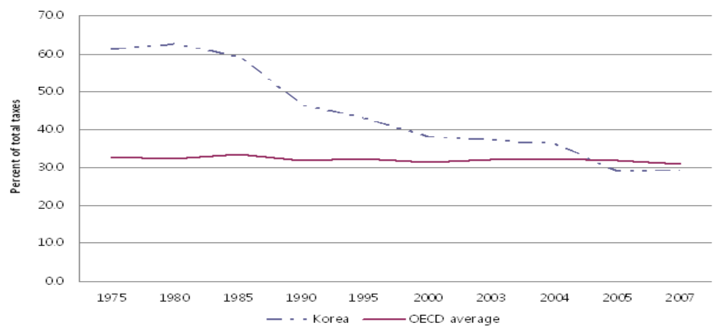
Fig. A15. Environmentally related taxes vs. Other taxes in Korea



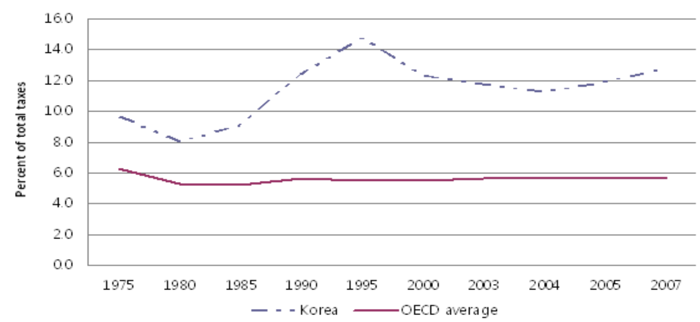
(a) Personal Income Taxes



(b) Corporate Income Taxes



(c) Consumption Taxes



(d) Property Taxes

Source: OECD Revenue Statistics, 2009

Fig. A16. Trends of Tax Structure : Korea vs. OECD average